Designing a System on System Wargame

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Abstract

The need for a System-on-System Wargame is identified and a design and development approach outlined. The wargame is designed in a modular and fractal manner with three nets (C3ISR, system, and environment), with each entity represented on each net. The term "Third Generation Wargame" is clarified. Several contracts supporting this effort have been completed, other contracts are in progress, and still others are in planning or pending award. An internal project is also in progress.

Introduction

Wargames differentiate themselves from other computer-based simulations in that they are opposed, rather than scripted, probabilistic simulations of warfare. Opposed simulations have the characteristic of involving two or more opposing "players" (who may be computer generated) operating in an act-react mode. Said another way, a wargame is played. These opposed simulations are typically designed from the top down, often treating warfare as a single pass through an extremely complex series of probabilistic interactions. This approach uses as observables the historical known inputs and outputs of warfare, and incorporates information available from other forms of analysis. Wargames also differ from Operations Research (OR) simulations in that the OR approach would be based on a bottom up analysis, based on first principles. [1]

Mind-on-Mind (1st Generation) Wargames

The first generation of wargames are mind-on-mind, requiring the players to attempt to outthink their opponents. These games were designed to teach a ruler how to outthink and thereby defeat the opposing ruler. Examples of this type of wargame are chess, go, and checkers.

Classic components of a first generation wargame would be the players, the simplistic forces, a simplistic operating environment, and a set of rules. The set of rules defines the interaction of all the components of the wargame.

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14. ABSTRACT

The need for a System-on-System Wargame is identified and a design and development approach outlined. The wargame is designed in a modular and fractal manner with three nets (C3ISR, system and environment), with each entity represented on each net. The term "Third Generation Wargame" is clarified. Several contracts supporting this effort have been completed, others contracts are in progress, and still others are in planning or pending award. An internal project is also in progress.

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Force-on-Force (2nd Generation) Wargames

As warfare became more complex over time, more accurate wargames emerged. These wargames can be characterized as force-on-force wargames, using attrition and probabilities. Probably the most classic example of a force-on-force wargame is Risk whose basic principles are the underpinnings of most wargames today; in fact, virtually all modern wargames are second generation designs.

Classic components of a second generation (force-on-force) wargame would be: the players, the forces involved, the operating environment, a set of rules, a mobility database, and a combat database. The forces involved are usually organizationally depicted down to the second level below the level at which the player is operating. Low availability and high value assets (like JSTARS or AWACS) may be depicted at lower levels. The operating environment would include the effective terrain, weather, transportation nets, etc. The set of rules grows more complex, but retains its function of rigidly defining game play and supporting the algorithms embedded within the mobility and combat rule sets. The mobility rule set would define the interaction of the forces with the environment (example: unit U in formation F would move over terrain T in weather condition C at a rate of R). The combat rule set in a similar manner would define the probable outcomes of the opposing forces interacting under the influence of a specific portion of the environment.

Need for Improvement

Recently many wargamers have noted that the current generation of wargames is inadequate for depicting the characteristics embodied in modern warfare. Concepts such as the "Revolution in Military Affairs", "Effects Based Operations", "Shock & Awe", "Operation Desert Storm" or even "Blitzkrieg" do not fit the mold of second generation wargames.. Analysis has shown that these inadequacies could be overcome by including three additional components within the wargames: systematic effects, variable unit response times, and inclusion of variable human factors. [2]

The excessively high casualty predictions for Operation Desert Storm can be attributed, in part, to three strategic errors that unfolded from force on force analyses and wargames: an early halt to the ground campaign, excessive disruption of homeland emergency medical services due to extensive call up of medical reservists, and inadequate POW handling (a general lack of MPs, stockades, provisions, etc.). Specifically, over 30,000 casualties were predicted because the computerized wargames used depicted the Iraqis as fighting to the last man. The few non-computerized wargames (Dupuy, Dunnigan, and Herman) also accounted to some extent for human factors, and C2 degradation. The wargames predicted casualty ranges of 200 to 2000, but were discounted during planning.[3]

The System on System (3rd Generation) Wargame

The next generation of wargames needs to retain all the components of the first two generations of wargames and add in components for incorporating systematic effects, variable unit response times, and variable human factors. There have been a few wargames developed that include some of these added components, but none have been comprehensive in scope. Good examples that the author is aware of would be some products from Breakaway Games, SSG, Decision Games, and Intellas M&S.

A System-on-System Wargame is currently under design and early development under the direction of the Air Force Research Laboratory's Information Directorate. The current design incorporates three interlocking nets of interaction: the C3ISR (Command, Control, Communications, Intelligence, Surveillance, and Reconnaissance) net, the system net, and the environment net (See Figure 1 below). The three nets are used to depict the three different ways entities will interact. Each entity is represented on all three nets, be it an oil refinery, a bridge, a mechanized infantry battalion, or a police car. Each entity is represented on each net by a modular net specific object.
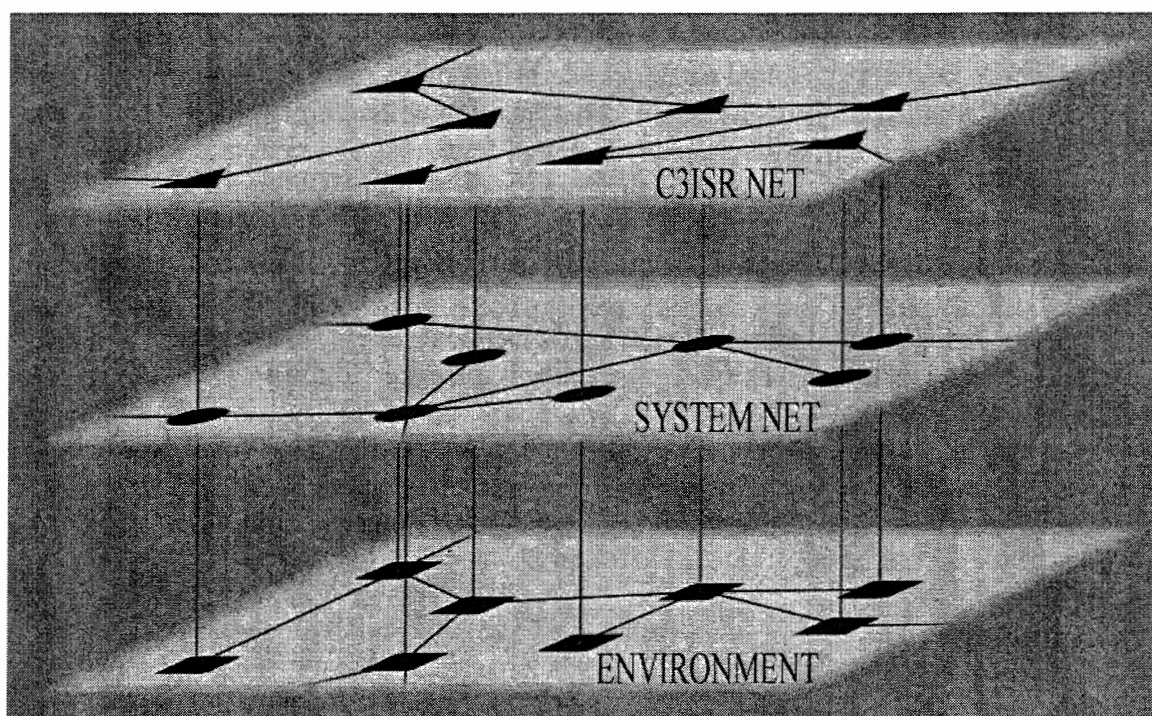

Figure 1 System-On-System Wargame Nets

Each entity module can be replaced in a fractal manner by several smaller entity modules if more detail is desired and available. Conversely, the reverse is also available (Plug & play replacement). For example, depending on need (e.g., desired simulation fidelity) and available information, the mechanized infantry battalion can be broken down into a headquarters and

headquarters company, three mechanized infantry companies (mounted or dismounted), and a heavy weapons company, or be abstracted back into the brigade formation to which it belongs.

The C3ISR function will incorporate the entity's Artificial Intelligence (AI) [Command and Control], the entity's objectives [Command, Control, Communications], and the entity's situational awareness [Communications, Intelligence, Surveillance, and Reconnaissance]. A significant impact of the inclusion of this net is the integration of the effects of C3ISR and Information Operations directly into the wargame results. The C3ISR function will maintain awareness of the entity's condition by communicating with the other functions (system and environment) and directing their activities. This function will also communicate with other C3ISR nodes on its net as appropriate.

The C3ISR function will make command decisions when awareness of sufficient situational changes occurs. This will not occur or occur incorrectly if the node has insufficient situational awareness due to no data, bad data, or information overload, dropping critical information from analysis. An entity's high entropy rating will slow the speed at which it can make decisions and increase the chance of reaching information overload conditions at lower information input rates.

The system function will incorporate the entity's personnel, capital equipment, expendables received and stored, outputs generated and stockpiled (firepower, mobility, electricity, repaired equipment) and internal repair capacity noted. This function will communicate entity condition to the C3ISR function, and mobility to the environment function. The system function will communicate to the system net the system's products; such as firepower, repaired equipment, and fuel. The entity's human factors entropy will be incorporated at this level as a degradation in performance based on training, morale, cohesion, fatigue, and command confusion level.

The environment function will incorporate the unit's location, terrain, local weather, posture, signature, and other observables. This is where the unit is tracked in the environment.

One design concept for this wargame is the utilization of shared libraries of modules developed by subject matter experts. Extensive help files, examples, and standardized interfaces are intended to make the process as painless as possible for these subject matter experts.

Progress on Development

Four contacts have been completed through AFRL in support of the general wargaming technology program, while two are currently in progress. Other efforts are in the planning stages. Several are in direct support of the System on System wargame. An internal project is in progress to flesh out the specific system architecture and module specifications.

Conclusions

The need for a System-on-System Wargame is identified and a design and development approach outlined. The wargame is designed in a modular and fractal manner with three nets (C3ISR, system, and environment), with each entity represented on each net. The term "Third Generation Wargame" is clarified. Several contracts supporting this effort have been completed, other contracts are in progress, and still others are in planning or pending award. An internal project is also in progress.

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2. "Toward a History –Based Doctrine for Wargaming", Lt Col M. Caffrey, Aerospace Journal, Fall 2000, pg. 33-56.
3. Ibid. pg. 51-52.